Offshore wind power integration in TWENTIES and beyond

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Twenties
Transmitting wind

Offshore wind power integration in TWENTIES and beyond

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SEVENTH FRAMEWORK PROGRAMME
EUROPEAN COMMISION

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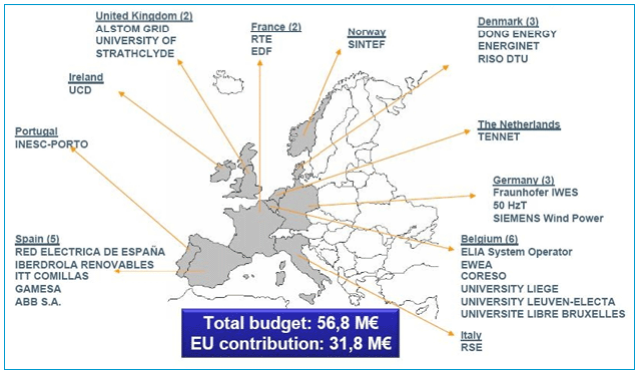
Project Partners and budget



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Project objectives

Task force 1: What are the valuable contributions that intermittent generation and flexible load can bring to system services?

Task force 2: What should the network operators implement to allow for off-shore wind development?

Task force 3: How to give more flexibility to the transmission grid?

Overall: How scalable and replicable are the results within the entire pan-European electricity system?

6 high level demonstration objectives

2 replication objectives

1 dissemination objective

3

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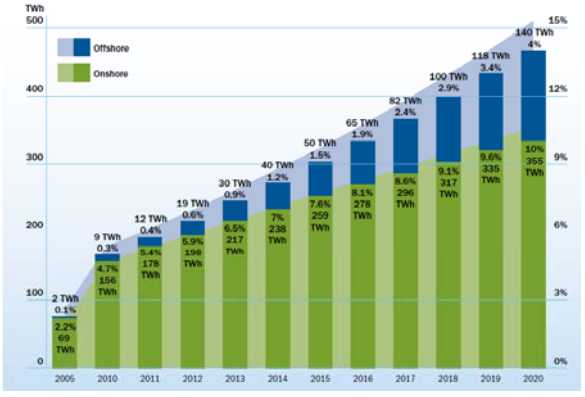
EWEA wind power development scenario



www.twenties-project.eu

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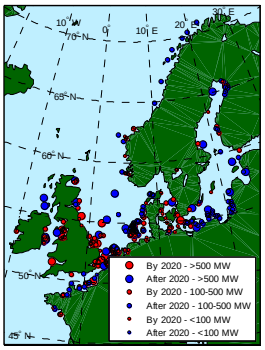
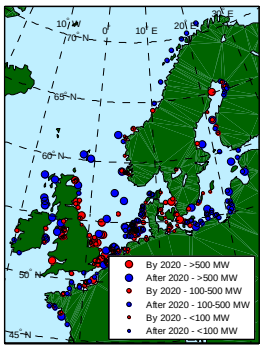
Detailed TWENTIES offshore wind power development scenarios



best guess

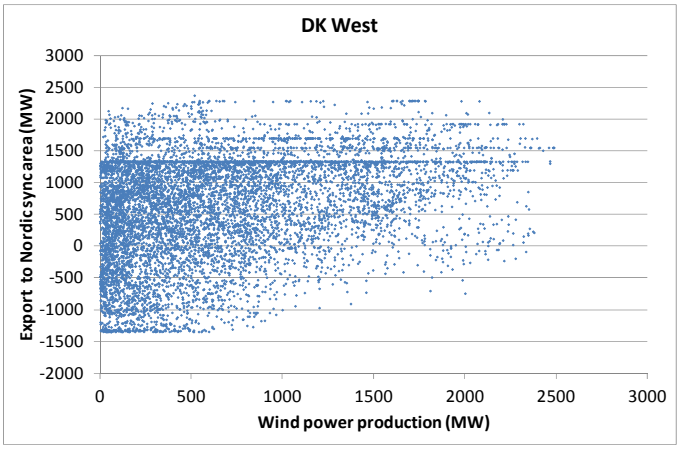


optimistic

Offshore wind power development scenarios

Installed (MW)	2020		2030	
	Best guess	Optimistic	Best guess	Optimistic
United Kingdom	13711	19381	41266	49718
Germany	8805	12999	28007	31247
Netherlands	5298	6298	13294	16294
France	3275	3935	5654	7039
Denmark	2811	3211	4612	5612
Belgium	2156	2156	3956	3956
Sweden	1699	3129	10385	11735
Ireland	1155	2119	3780	4783
Finland	846	1446	3733	4833
Poland	500	500	5300	5300
Norway	415	1020	10130	12925
Estonia	0	0	1600	1695
Lithuania	0	0	1000	1000
Latvia	0	0	900	1100
Russia	0	0	500	500
SUM	**40671**	**56194**	**134117**	**157737**

Wind generation and export to Nordic sync. area



Hydro potential and barrieres

- Potential increased generation capacity
  - Sweden/Finland: increase unlikely
  - Norway:
    - 11.5 GW (upgrade of existing)
    - 3.5 GW (new reservoir) capacity possible
- Potential increased pumping (load) capacity
  - 10 – 20 GW in the south of Norway
  - Theoretical potential 50 GW in Sweden (Vänern/Vättern)

Offshore grid scenarios – simple or complex

- The simplest Tradewind case with separate interconnectors and offshore wind plant connections
- EWEA 2030 offshore grid vision (Jacopo Moccia Nov 2010)

DEMO 4 STORM MANAGEMENT (Leader: Energinet.dk)

Main objective

- Demonstrate shut down of wind farms under stormy conditions without jeopardizing safety of the system

Approach

- Horns Rev 2 (200MW)
- Flexible turbine control
- **Storm front forecasts**
- Investigate cost of changed production associated with the planned down regulation
- Coordinate wind farm control with HVDC interconnector control and with hydro power plant operation

Geography

- **Storm events at Horns Rev 2**
- **Balancing area: West Denmark**
- **Imbalance will flow to Germany**
- **Regulating power can be traded via Skagerak**

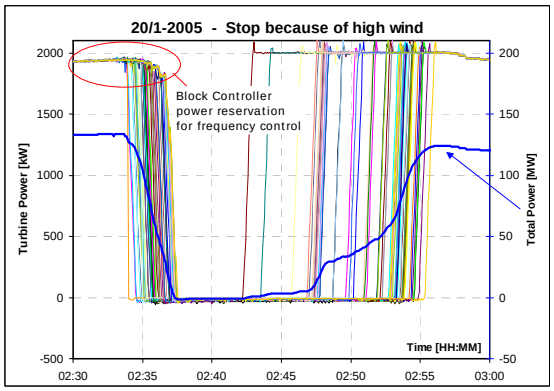
11

Future offshore projects in Denmark

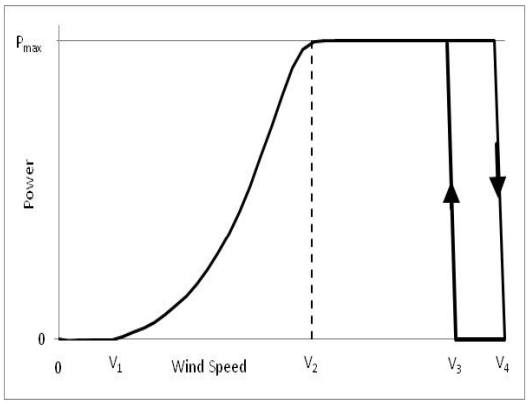
Total 4.6 GW

12

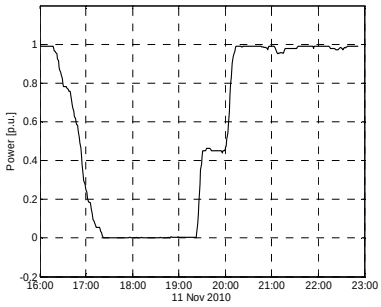
Storm example – Horns Rev 1 – 2005-01-20



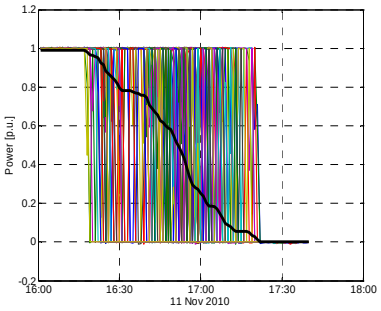
Wind turbine storm control



Storm example – Horns Rev 2 – 2010-11-11

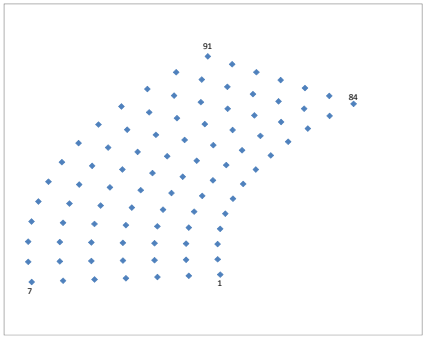


Produced wind power

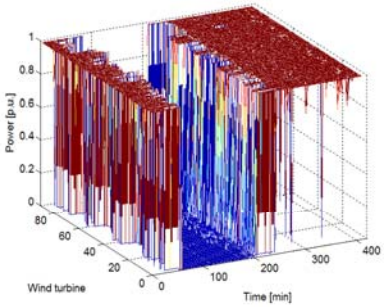


Wind turbine and wind farm production

Individual wind turbines powers

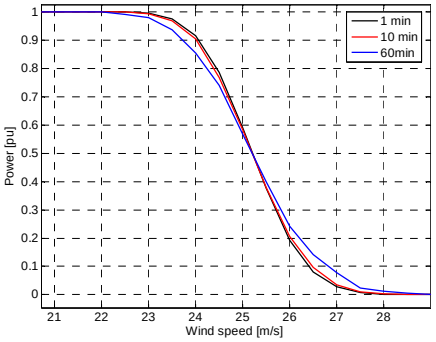


Horns Rev 2 wind farm layout

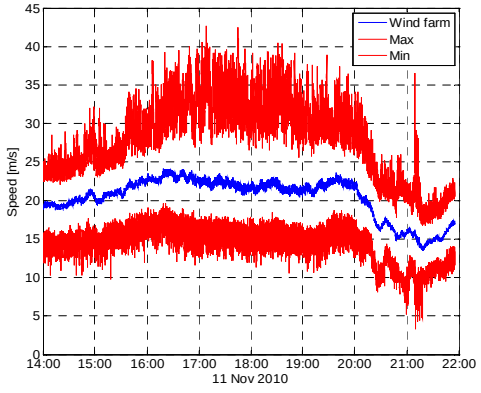


Horns Rev 2 wind turbine production

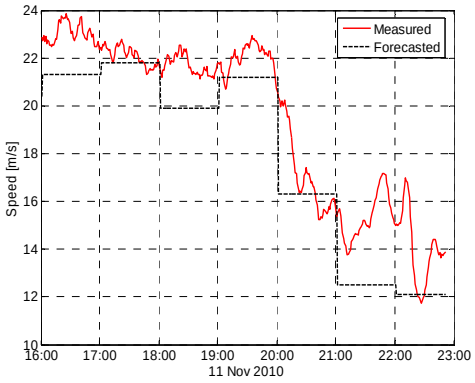
Wind farm power curve



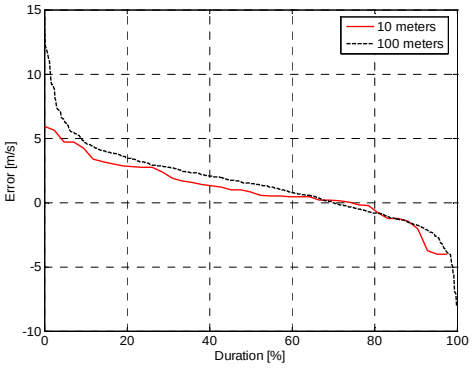
Wind speed variations over wind farm



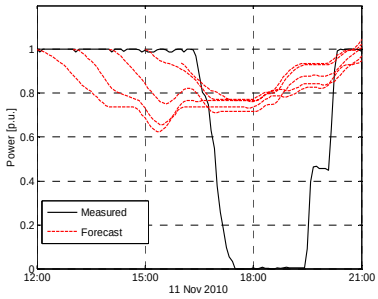
Measured and forecasted wind speeds



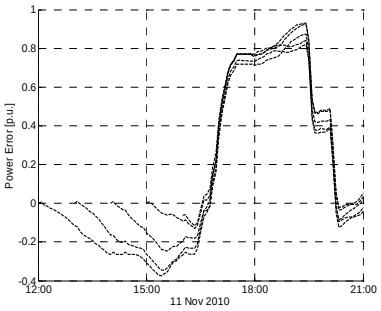
Wind speed forecast errors at high wind speeds



Rolling forecasts before a storm

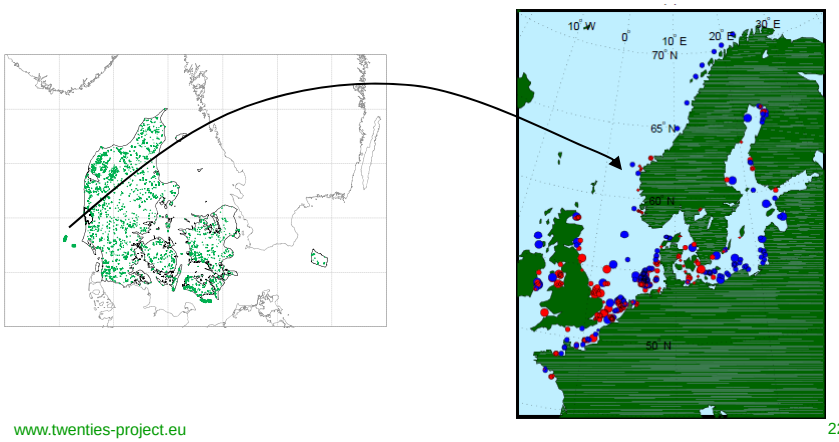


Measured versus hourly intra-day forecast wind power



Wind power forecast error

Upscaling of Horns Rev 2 to > 100 GW offshore wind



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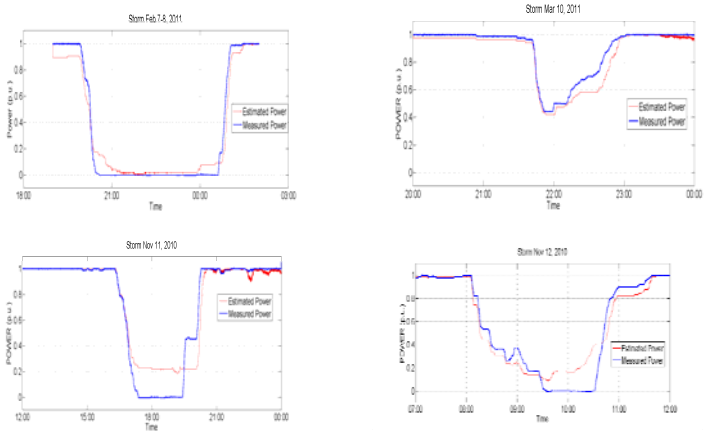
Storm control – measurements and simulations



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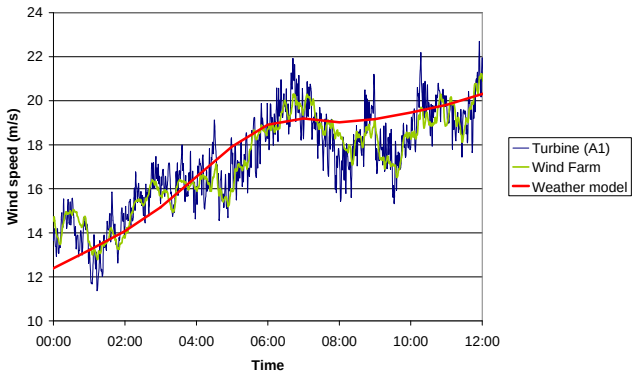
Wind speed simulations for 2020 and 2030 assessment – Mesoscale and CorWind simulations



Conclusions

- Offshore wind power development is on an early stage today, and will contribute massively to future European energy supply
- Hydro power in North Europe already balances wind power variability, and there is a significant potential for more hydro power, also pumped
- Wind power forecasts at high wind speeds are not reliable; partially because power curves are discontinuous for storm wind speeds
- A more smooth wind turbine storm control will be demonstrated
- It is expected that wind power forecast errors will be improved by implementing the new control algorithm.
- TWENTIES project will assess the European impace 2020 and 2030 of planned offshore wind power

Thank you

Twenties: www.twenties-project.eu

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